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BINARY-ADDRESSABLE SCAN CONVERSION STORAGE TUBE

SECOND QUARTERLY REPORT

BY
D. MERGERIAN, J. W. OGLAND, H. J. BOURG, & I. LIMANSKY

MAY 1972

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WESTINGHOUSE ELECTRIC CORPORATION
SYSTEMS DEVELOPMENT DIVISION
POST OFFICE BOX 746
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13. ABSTRACT

This is the second quarterly report on Contract No. DAAB07-72-C-0052, covering the period from 15 January to 14 April 1972. The objective of the contract is to conduct a research and development program leading to the fabrication, testing, and delivery of a binary-addressable scan-converter storage tube. The tube is to be capable of simultaneous write and non-destructive read operation at video frequency up to 10 megahertz.

Experiments were performed for producing the hole-array, consisting of 512 x 512 holes, 0.001-inch in diameter on 0.003-inch centers, in silicon wafers. Both photoanodic etching and laser drilling were explored, ~~and~~ the latter proved successful. The designs for the contact strip arrangements on the disks were finalized, and the various fixtures were manufactured for control of photo-resist exposure and for securing registry of the hole-arrays of the sequence of digitizer-disks. The digitizer consists of a self-contained unit that can be completely pretested, after which a writing-gun assembly and a reading-gun assembly are heliarc-welded to it on opposite sides. The designs of the final version of the latter gun-assembly and a preliminary version of the former are finished, and both are in the process of being manufactured.

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PUBLICATIONS, LECTURES, REPORTS, AND CONFERENCES

Dr. D. Mergerian & H. J. Bourg of Westinghouse, Systems Development Division, visited ECOM on 6 April 1972 to review the revised schedule and plans for performance of this contract with I. Reingold and M. Crost, the Government COR's for this program. The problems encountered in attempting to etch holes in the digitizer plates were discussed, along with the two possible solutions to these problems, utilizing photoanodic etching or laser hole drilling. With respect to the latter of these two possible options, the purchase of a new laser hole-drilling facility by Westinghouse was discussed, and a revised schedule based on this approach was reviewed.

It was concluded that Westinghouse would proceed with the laser hole drilling approach, but would also continue to experiment with the photoanodic etching technique, since this latter technique would be preferable if the tube were to become a production item.

Further discussions involved the use of a low current-density writing gun, as part of the Phase-I effort, for the purpose of determining the digitizer plate transmission. While the use of such a gun would not permit the desired writing speed, it was agreed that this was of no consequence in the Phase-I program, and the information gained would aid in the design of the write-gun to be employed in the Phase-II tube.

M. Crost also raised several questions with regard to the mechanical arrangement of the digitizer-plate assembly as outlined in the first quarterly report. These questions were answered by pointing out the rationale behind the Westinghouse tube design.

I. INTRODUCTION

This program is directed toward the development of a binary-addressable scan-converter storage tube capable of simultaneous electrical write-in and electrical read-out. The video signals involved in either or both writing or reading signals may include frequencies ranging from 0 to 10 Megahertz.

Means shall be provided for prevention of crosstalk between writing and reading signals. Carrier-frequency modulation of the reading beam may be employed for this purpose, but other and simpler means will be explored. The writing gun is to provide a beam uniformity of 2% over the target area. The program is to be performed as a two-phase development effort.

Phase-I will result in a digitally-addressed scan-converter storage tube capable of 512 x 512-element resolution. The major effort will be directed toward development and optimization of the binary-address matrix. In conjunction therewith the electron entrance efficiency from the flooding beam will be established, and the current-density will be determined which will yield full signal-strength at 0.1 μsec spot-dwell time. A conventional magnesium fluoride target will be employed.

Phase-II will result in a scan-converter tube capable of 1024 x 1024-element resolution. A silicon-silicon dioxide storage-target and an improved writing gun capable of charging the target elemental capacitors to full signal-strength at full writing speed will be employed.

The efforts on development of the scan-converter storage-tube

during the period 15 January to 15 April have covered the several subassemblies of the tube, which, to a great extent, can be developed independently. The design of the central part of the tube, the digitizer assembly, has been finalized, and some components have been fabricated. The feasibility of laser-drilling of the hole-array has been established. The patterns of contact strips have been laid down, and means have been provided for securing registry between the individual disks.

The design of the reading-gun assembly, as well as the initial writing-gun assembly, have been established, and the necessary orders have been placed with the Westinghouse Tube Division. The first deliveries are expected at the end of May.

Fabrication of a demountable test station has been initiated that will permit comprehensive testing of the writing-gun, as well as the complete digitizer assembly.

A detailed description of the progress made on the various parts of the tube is given in Section II of this report.

II. TUBE DESIGN

The starting point for the design of the binary-addressable scan-converter storage tube (WDX-233) was the approach outlined in our proposal. Certain changes were made in the original design in order to improve construction of the device, for example, the digitizer is developed as a separate unit inserted laterally, complete with its terminals, into its independent metal housing. The two guns are developed and fabricated as separate units (in glass envelopes with metal flanges), and after proper quality control and testing are heliarc-welded on either side of the digitizer housing.

By the use of a special demountable test station, this arrangement permits comprehensive pretesting of the complete digitizer-assembly, the most expensive component of the binary-addressable scan-converter storage tube. Furthermore this arrangement permits independent measurement of the current-uniformity of the writing gun, as well as optimization of all parameters.

The effort devoted to and the progress made on the various components and subassemblies are described below in accordance with this subdivision.

A. DIGITIZER ASSEMBLY

1. Digitizer Hole-Array Production

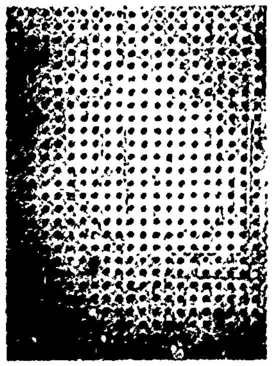
Initially the main effort was devoted to producing the hole-array in the silicon wafers, consisting of 512 x 512 holes, 0.001 inch in diameter

on 0.003 inch centers. Two avenues of approach were maintained during this quarter, photoanodic etching and laser drilling.

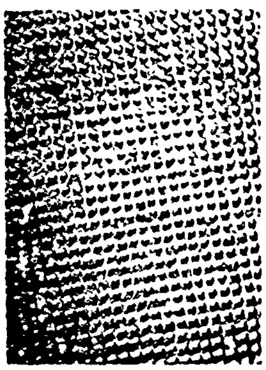
The preferential photoanodic etching was continued on (110)-oriented, 10 ohm-cm, N-type silicon. Several light-intensities were used, as well as several etch-solution strengths. In all cases the mask was severely under-cut to the point of complete etching of the hole-walls, regardless of the degree of alignment. Since the walls of the holes are {111} planes and they were completely etched through in less than one hour, it is apparent that photoanodic etching is accelerating the etch-rate. Initially it was believed that the light was falling on the walls of the holes and causing this accelerated attack. However, optimum alignment and collimation of the light beam did not alleviate the problem. A closer investigation showed that regardless of where the light was incident within the hole, the photo-voltage would appear on the entire surface of the hole, since the voltage drop caused by conduction to nonilluminated areas would be minimal in 10 ohm-cm material. Thus for preferential photoanodic etching to be successful, it must be done on semi-insulating material. The only available experimental material in-house has a resistivity of 10 ohm-cm or less. Plans have been made for getting some semi-insulating (110) material for further experimentation.

Concurrent with the etching experiments, laser-drilling experiments were performed. After initial tests, our numerically-controlled step-and-repeat laser drilling station was set up for production of a 100 x 100 array of 0.001"-diameter holes on 0.003" center-to-center spacings. Figure II-1 is a photomicrograph of a region within this array at various steps in the production of the array. The magnification is 50X. Figure II-1a is a

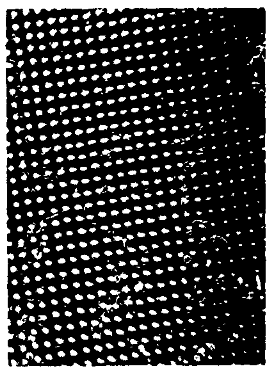
(a)
50X MAGNIFICATION
As drilled, without etching.



(b)
50X MAGNIFICATION
After etching for 1 min. in concentrated HF & 2 Min. in HNO_3-HF solution.



(c)
50X MAGNIFICATION
After Etching 1 Min. in HF & 12 Min. in HN_3-HF Solution. Illumination from both top & bottom of wafer.



(d)
50X MAGNIFICATION
Same as 3 with illumination only from below wafer. Apparent distortion of hole shape in photograph is due to the illumination being incident at an angle.

Figure II-1. Photomicrographs of 100 x 100 Array of Holes in Silicon

photograph of the array as it appeared just after drilling. Light is incident from both the top and bottom of the wafer. Severe oxidation and redeposited material have completely plugged all but a few of the holes. After etching for one minute in concentrated hydrofluoric acid and two minutes in a nitric acid-hydrofluoric acid solution, all of the oxidation and redeposited material on the surface of the wafer has been removed, although the majority of the holes are still plugged. This can be seen in Figure II-1b. The non-circular nature of the holes in this photograph is due to vibrations, which will be eliminated with proper isolation of the equipment. Figure II-1c shows the result of an additional ten-minute etch in the nitric acid-hydrofluoric acid solution. The majority of the redeposited material has been removed from the holes. The light is incident from both sides of the wafer in the photograph. The apparent distortion of the hole-shape is due to the light from the bottom side of the wafer being incident at an angle. Figure II-1d is the same as Figure II-1c, except that the light is incident only from the bottom. As a result of the experiment, laser drilling of the 512 x 512-hole array appears quite feasible and can be accomplished in a reasonable amount of time. The walls of the holes are reasonably vertical through the 0.005" of silicon using the short-focal-length (approx. 3/8 inch) facility.

Although laser drilling of the hole-pattern proved successful in these test runs, the greater wafer thickness (approx. 0.010 inch) required for rigidity makes it necessary to modify the equipment to a longer focal length and therefore a less-steeply converging beam. Unfortunately, the combination of equipment-modification and quite time-consuming runs for a full pattern proved incompatible with work previously scheduled for this equipment. This phase of the program, therefore, had to be postponed until arrival of

another laser-drilling facility, procured especially for this contract, and which is expected to be in operation in the early part of June.

2. Digitizer Plate Fabrication & Assembly

The actual laser-drilling of the hole-array in silicon wafers is the last step in the disk preparation. Therefore, the effort has continued on the fabrication of the digitizer-assembly, procurement of components, deposition of contact strips, and preparation of alignment-notches, as described below.

The order in which the digitizer plates will be assembled into a stack is illustrated in Figure II-2. Plate #1 is nearest the digitizer base-plate. Figure II-2a shows the connections between Plates 1, 2, 3, & 4 and the fan out pattern. Each of these plates has four leads going to the fan-out pattern. Plate #1 will be placed on the mounting-rod first, and the leads will be thermal-compression bonded between the wafer and the fan-out pattern. The ceramic spacers will then be put in place, followed by Plate #2 and its connections. This procedure will be repeated until all six plates have been mounted and the proper connections have been made. The digitizer-plate is an assembly of the silicon wafer, with the hole-array and the proper electrode-pattern, mounted on a 0.050" molybdenum plate. The molybdenum plates are allowed to hang over each other in going from Plate #1 to Plate #4 so that the wire lengths are kept to a minimum, and the possibility of the wires falling to the next lower plate and shorting will be eliminated. Molybdenum was chosen for this application because it is non-magnetic and can be coated with Al_2O_3 for insulating purposes. Figures II-2b & c show the connections to Plate #6 and #5 respectively. Again, the plate to which connection is being made is allowed to hang over. As viewed from the flood-gun side, the connection to

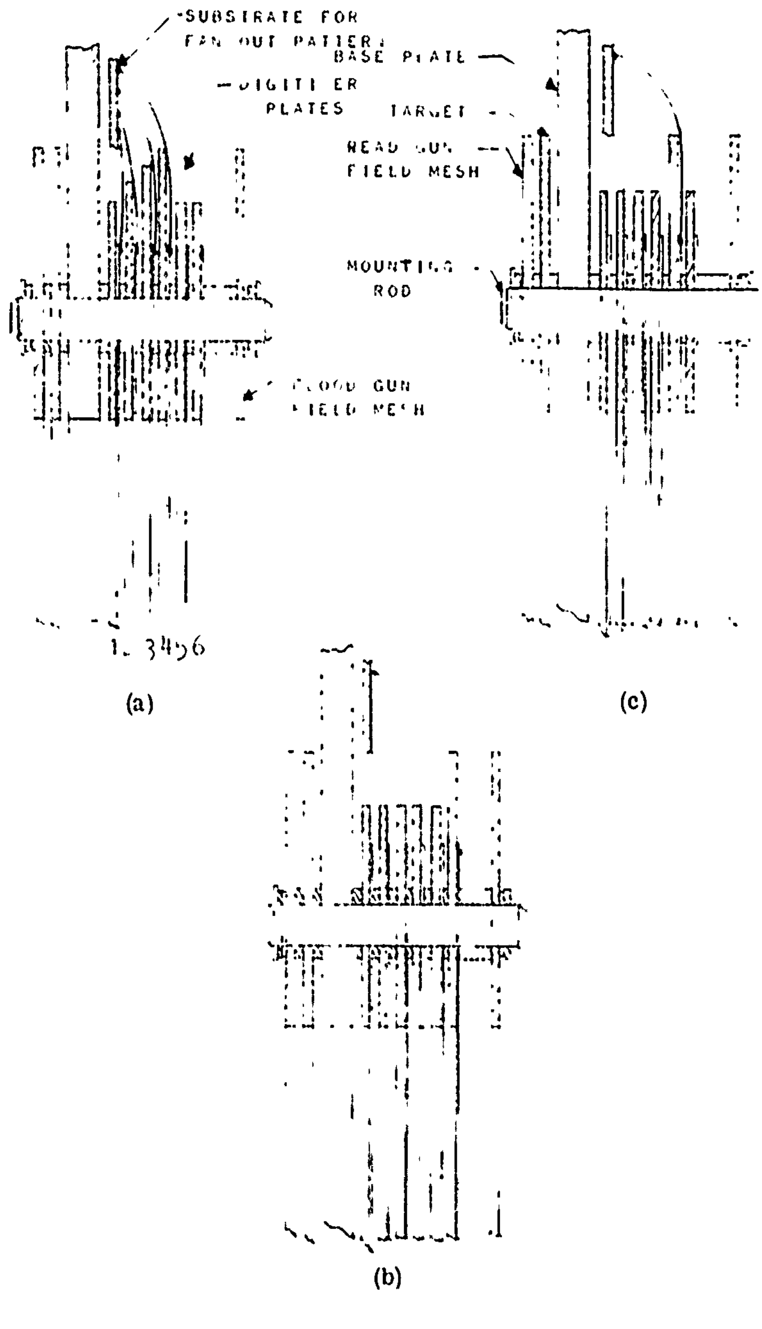


Figure II-2. (a) Digitizer assembly, showing connection between Plates 1, 2, 3, 4, and fan-out pattern.

(b) Digitizer assembly, showing connections between Plate #6 and fan-out pattern.

(c) Digitizer assembly, showing connections between Plate #5 and fan-out pattern.

Plates #1 through 4 will be to the left, Plate #5 to the right, and Plate #6 on the top. Connection to the collection electrodes on the back-side of each wafer will be taken out to the left of the stack, as viewed from the flood-gun. The connection to the silicon wafer, which allows collection of electrons deposited on the hole-walls, will also be taken out from the left side. There will thus be 32 connections between the digitizer-stack and the fan-out pattern on the top and right side and 28 on the left side.

The fan-out pattern is a thick-film LSI circuit deposited on a horseshoe-shaped ceramic substrate which is located adjacent to the top and two sides of the digitizer assembly. This substrate is shown in Figure II-3.

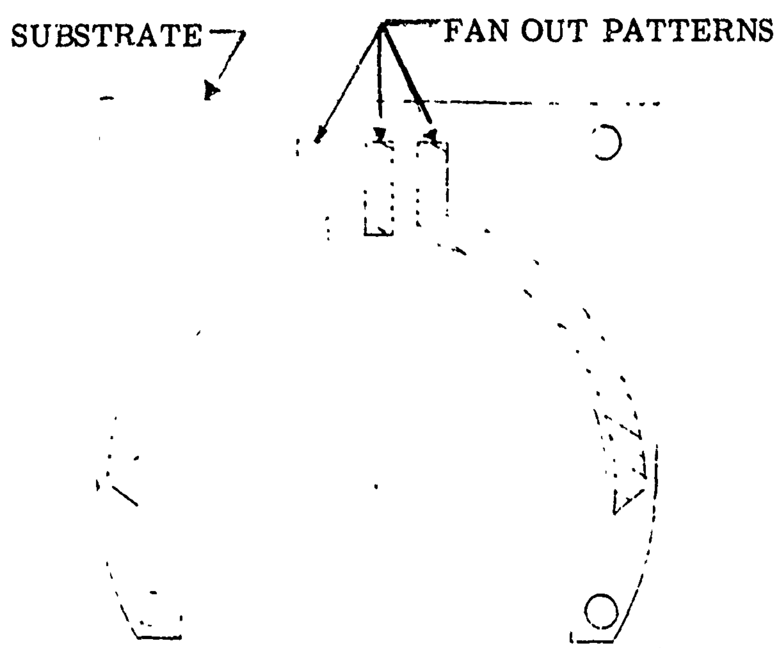


Figure II-3. Ceramic substrate and fan-out pattern used to interconnect the silicon digitizer-plates to the vacuum feedthrough.

Figure II-4a is an illustration of the bus-bar pattern used on Wafers 1 & 3. If the individual electrodes within a group are numbered consecutively 1-4 starting from the top, the bus-bar numbering gives the address within any one group which is controlled by that bus-bar. This connecting sequence allows maximum separation between connections to the

bus-bars. The procedure for depositing the bus-bars and electrodes is as follows:

(1) Oxidize wafer,

(2) Deposit bus-bars 1 & 2 and associated electrodes,

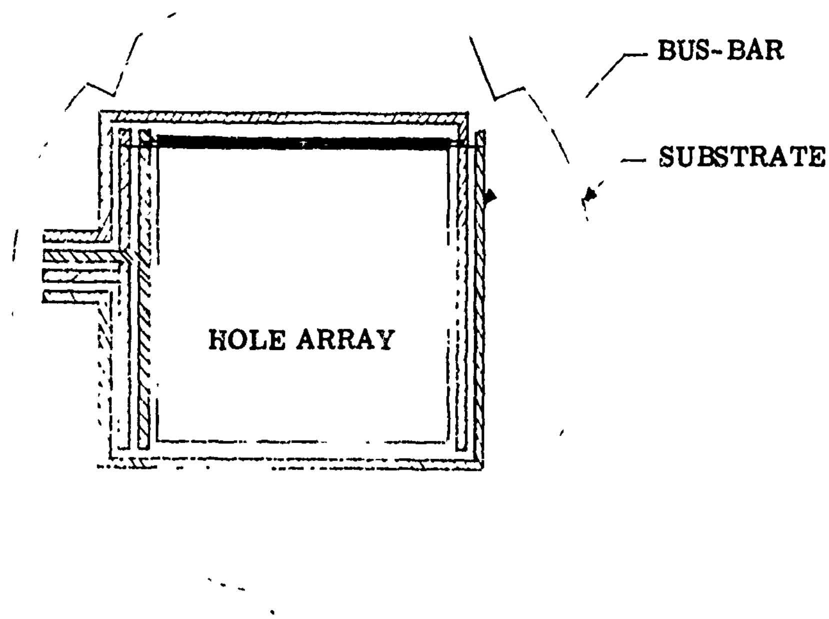
(3) Oxidize,

(4) Deposit bus-bars 3 & 4 and associated electrodes.

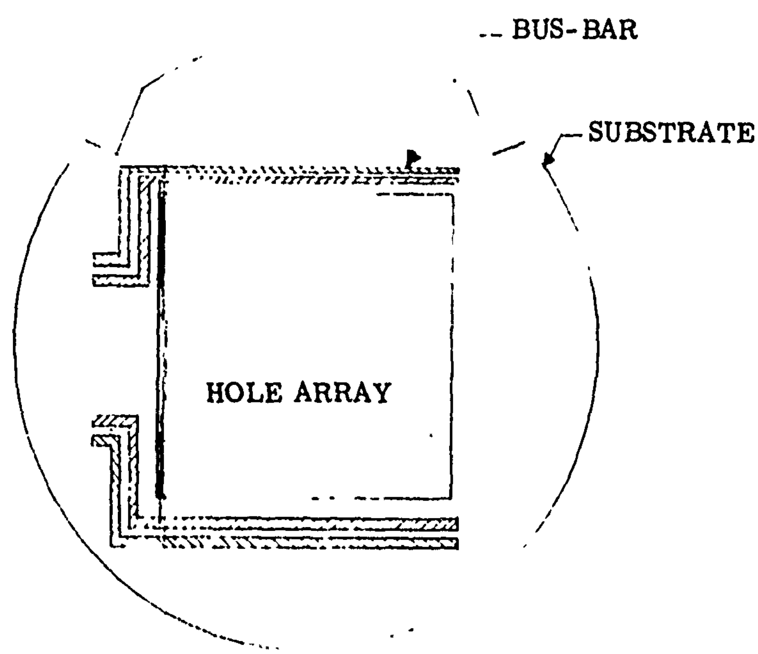
This design, in connection with the above procedure, allows a minimum number of crossover points between bus-bars. Figure II-4b illustrates the bus-bar pattern used on Plates 2 & 4. They will be deposited using the same procedure as on Plates 1 & 3; however, the starting point for counting the electrodes is to the left instead of the top. Figures II-5a & b are the electrode patterns for Plates 5 & 6, respectively. The electrodes on these plates encompass an array of 16 x 512 holes, and no bus-bars are required, since multiplexing is not used on these two plates. All of the electrodes will be deposited simultaneously on these two plates, with no intermediate oxidizing step.

3. Digitizer-Plate Alignment

Prior to deposition of the electrodes and bus-bar pattern, two 90° vee-notcnes are diamond-ground into the wafers, as shown in Figure II-6. The faces of these notches have a 32-microinch finish. The notches serve three purposes. Primarily they allow precision alignment of the individual wafers in the final digitizer-stack by indexing all the wafers to the same precision-OD rods. Secondly they establish two alignment-points for the photolithography masks used in defining the electrodes and bus-bars. Finally, they establish two alignment-points for placing the wafer on the laser-drilling apparatus so that the hole-array is accurately poisitioned

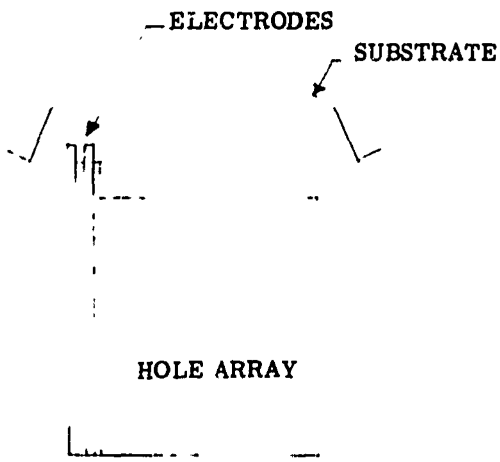


(a)

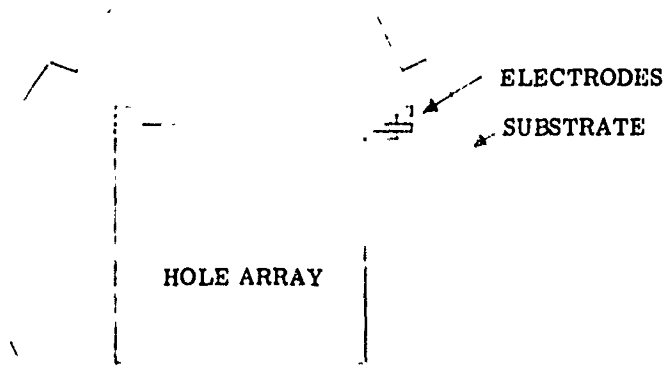


(b)

Figure II-4. Bus-Bar Pattern Used on Wafers 1 & 3



(a)



(b)

Figure II-5. Electrode Patterns for Plates 5 & 6

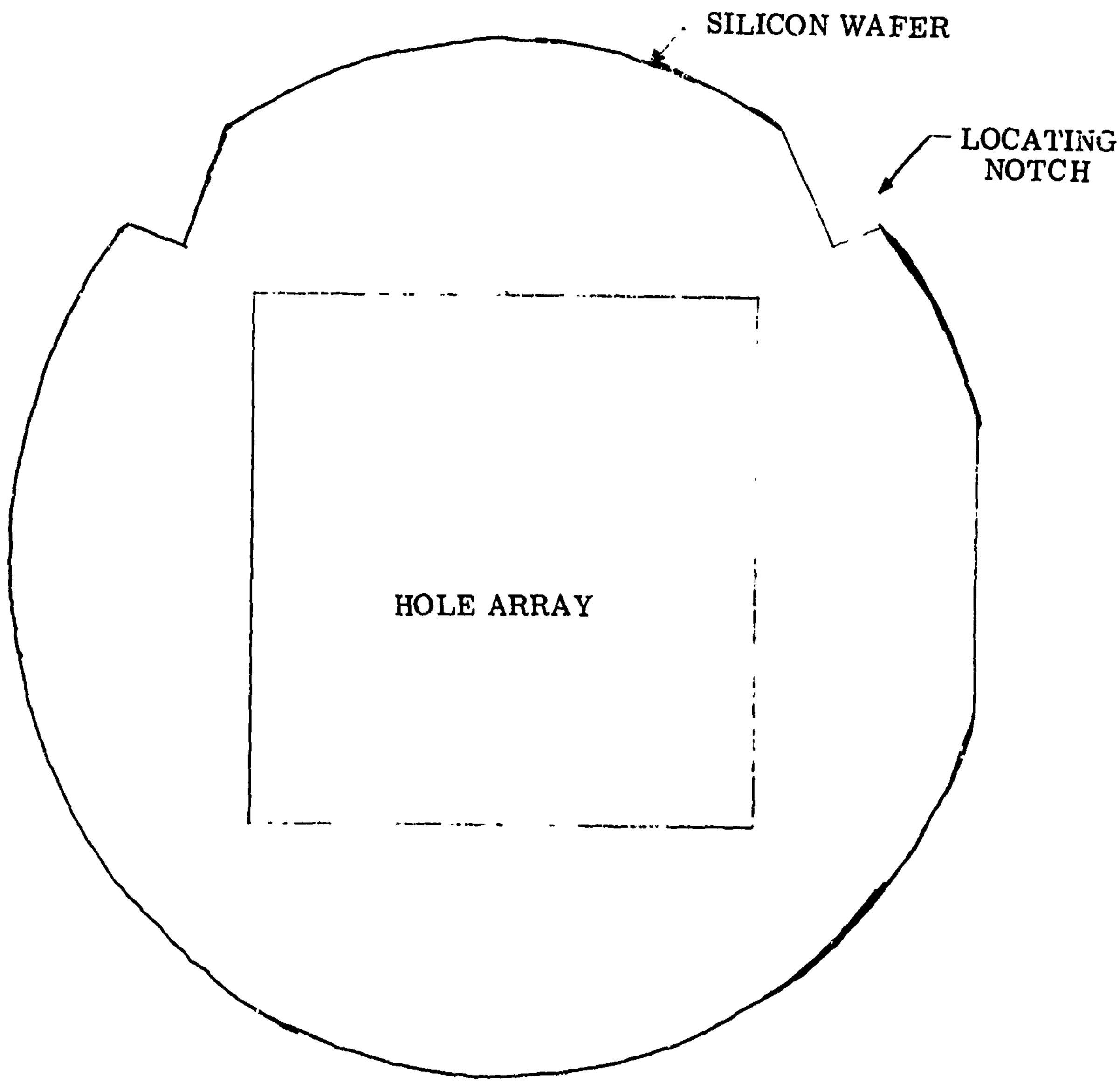


Figure II-6. Silicon Wafer with Vee-Notches & Hole Array

with respect to these points. Therefore, since all of the indexed to the same rod, and the electrode and hole-patterns are also accurately located to these indexing points, good alignment in the final stack will result.

Since the notches in the wafers are the key to alignment, it is necessary that they be identical on any two wafers. To insure absolute identity between individual wafers, all wafers are ground simultaneously. This has necessitated the design and construction of the grinding fixture shown in Figure II-7. It is a precision block with angles ground on the bottom. The angle is 22^{o},30' off the horizontal. All of the wafers are waxed together, with less than 0.001" of wax between any two wafers, and then waxed into this fixture. The fixture with the wafers is then placed on the grinding machine, with the block lying on one surface, and the corresponding notch is ground. The block is then shifted to the other alignment-surface, and the second notch is ground. To reduce the possibility of high stress-concentration, resulting in the wafers cracking, they have been stress-relieved prior to grinding. The grinding will result in microscopic mechanical damage to the silicon, resulting in additional stress-concentrations. These will be removed prior to separation of the waxed wafers. This will result in a strain-free set of wafers in which all of the notches are identically spaced, thus facilitating absolute alignment of the hole-array and electrode pattern.

Figure II-8 is a photograph of the fixture used to define the electrode and bus-bars on the silicon wafers. Part A is a vacuum chuck, which holds the wafer against the two alignment-pins and holds it down. This part is removable and will also be used to hold the wafe[illegible] laser-drilling of the holes, thus maintaining hole-alignme[illegible] is a

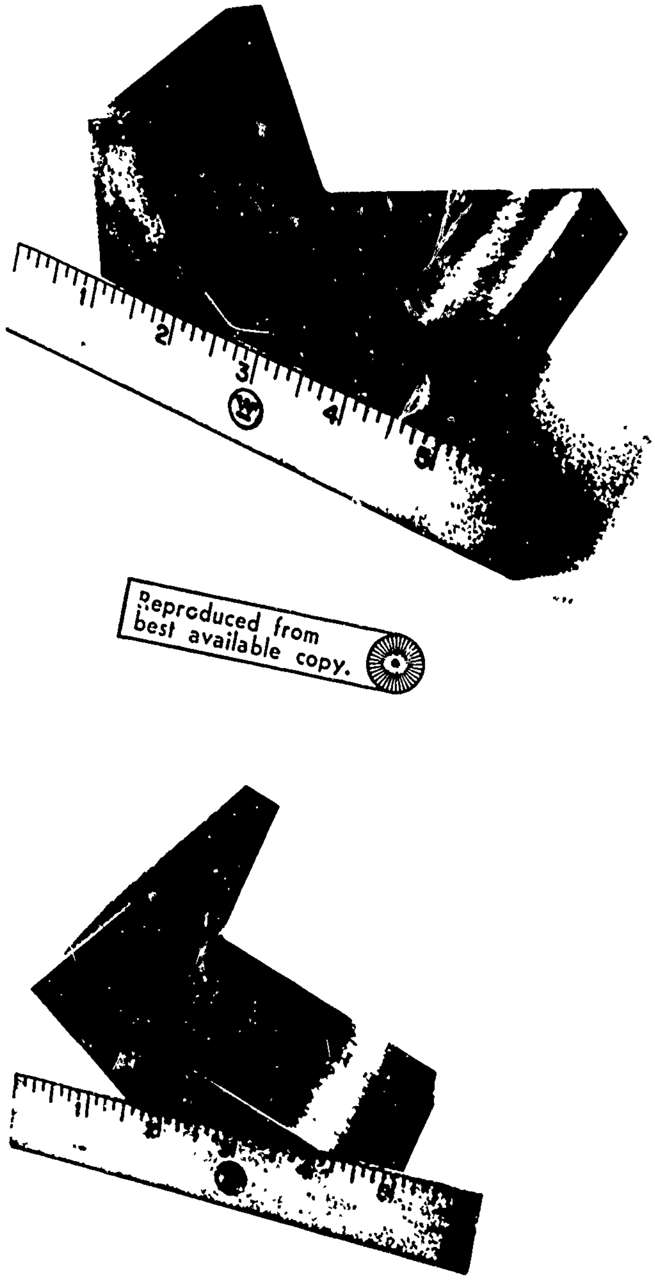
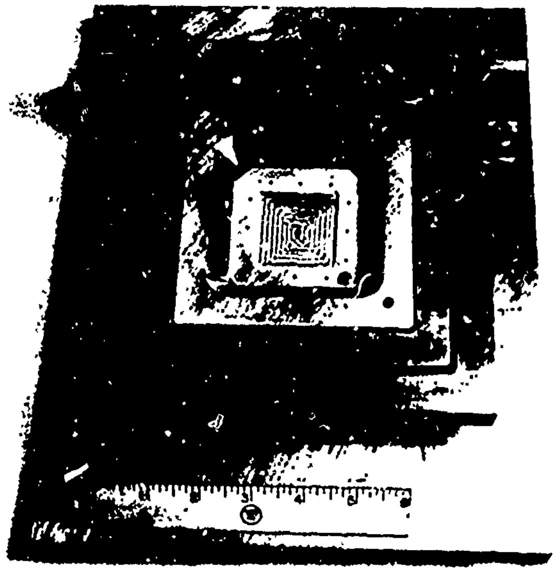


Figure II-7. Grinding Fixture

triple-gimballed mask-holding fixture. The appropriate photolithography mask will be placed in this fixture and will be optically aligned to the notches in the wafer held by Part A. It will then be clamped to the fixture. Several wafers can be exposed, once the mask is aligned, by simply raising the mask-holding fixture and replacing the wafer, thus eliminating the need for realignment. The necessity of aligning the photolithography mask to the notches required this fixture-design, since no other available mask-alignment devices are capable of aligning masks to the outer periphery of a 3"-diameter wafer. This fixture thus allows alignment of the photolithography mask to the notches on several wafers to within a few micrometers, without the need for realignment upon changing wafers.

4. Digitizer Housing

To prevent residual magnetic-field interference with the electron optics within the digitizer-stack, it is desirable to use non-magnetic materials for all piece-parts in the vicinity of the digitizer plates. This was the prime reason for using molybdenum for the wafer mounting plates within the digitizer-stack. For the same reason the digitizer housing is made of No. 304 stainless steel. Figure II-9 is a photograph of the housing and adjacent parts. Part A is the housing, which is composed of five piece-parts assembled with all internal heliarc-welds. Part B is the stainless-steel flange onto which the digitizer base-plates will be connected via the two tabs. It will contain all of the vacuum feedthroughs making connection to the digitizer plates. This flange is compatible with the vacuum-



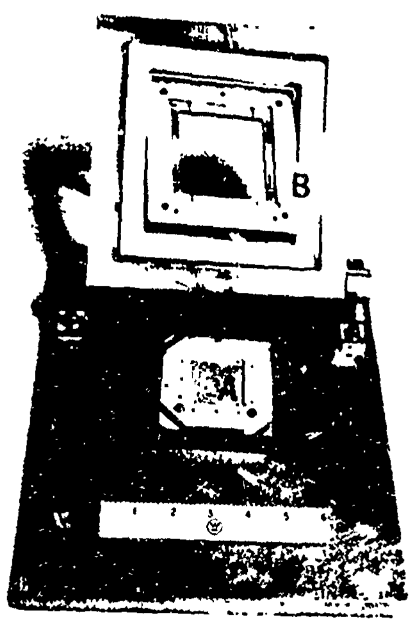


Figure II-8. Electrode Mask Deposition Fixture

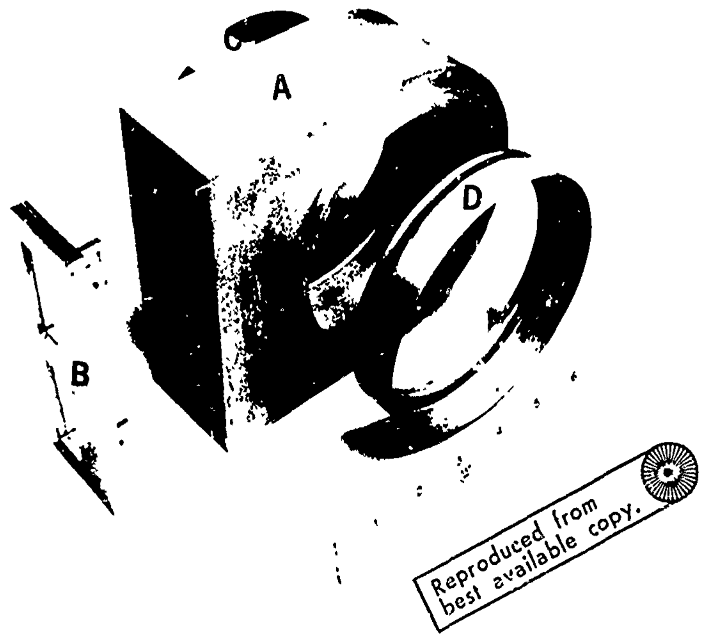


Figure II-9. Digitizer Housing

demountable which will be used to check the operation of the digitizer-stack prior to assembly into the tube. Thus the heart of the tube, the digitizer-stack and associated connections, will undergo operational checks prior to assembly into the tube. Parts C & D are the flood-gun and reading-gun mounting flanges, respectively. Because of the need for a glass-to-metal seal at these points, Kovar is used. This material is magnetic but is removed from the vicinity of the digitizer-stack, so that the effect on the digitizer electron-optics is minimal. Final machining of the welding lips for the digitizer-flange, Part B, and the flood-gun and reading-gun flanges, Parts C & D, will be done after all assembly welding on the housing has been completed. This will eliminate any distortion of the final machined housing

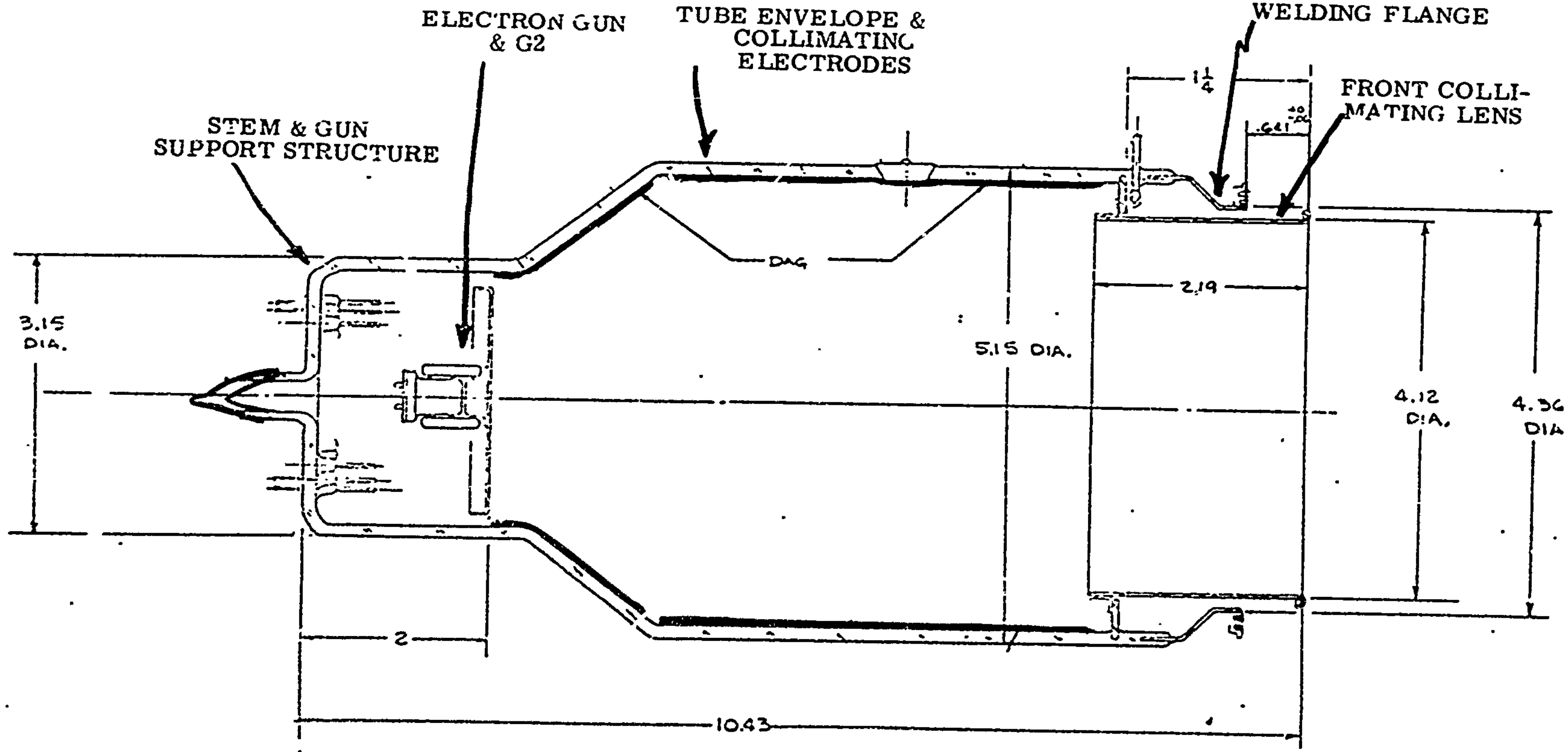
caused by welding. This tube-design will allow assembly of all three operational parts - flood-gun, read-gun, and digitizer-stack - onto the housing with three final closure heliarc welds, and thus it will reduce the possibility of assembling a non-operational part into the final tube.

B. WRITING GUN

As noted in the First Quarterly Report, the design of the writing flood-gun for the first version of the WDX-233 is based on a commercially available flood-gun and collimating structure, namely that of the Westinghouse storage tube Type 7268A. Figure II-10 shows the basic features of the gun and collimating electrodes. The collector-mesh, although normally considered a part of the collimator, is, however, attached to the digitizer assembly. Greater accuracy in spacing and parallelism is thereby secured, as needed for a uniform decelerating field across the tube. The first collimating lens is mechanically attached to a Kovar ring imbedded internally within the glass envelope. It protrudes past the welding flange, which acts as a glass-to-metal transition and permits heliarc-welding of the complete gun assembly to the digitizer housing. The gun yields 2 milliamperes at 100 volts on electrode G2.

A total of six mounts has been ordered from the Westinghouse Tube Division. This quantity allows for guns to be used also in the demountable digitizer test stand for uniformity measurements, as well as for measurements and optimization of the digitizer parameters. Present scheduling calls for delivery of the first start near the end of May.

The current actually landing on the storage-surface for information storage is only a small fraction of one microampere. However, since all apertures of the digitizer except one are blocked at any one time, the



All Dimensions Given in Inches

Figure II-10. Flood-Gun for Digital Scan-Converter

current ahead of the digitizer may be about six orders of magnitude larger. Therefore, to provide the writing speed required of the tube of Phase-II, a gun will be needed that emits a very strong and well collimated beam. To produce the consequent high current-density, a high accelerating voltage is needed, followed by deceleration to about 10 V at the entrance to the digitizer. Unfortunately, this process leads to power losses and undesirable heating effects. Furthermore, the current intercepted within the digitizer itself produces heating.

To minimize these effects, two approaches have been taken. First, the two-milliampere gun of Phase-I, in conjunction with the demountable test structure described in Section II-D, will allow experimental study and measurement of target-current versus gun-current. It is hoped that experiments with variations of electrode voltages will lead to improvements in this current-ratio and therefore to a more conservative gun-design. It is also possible that space-charge effects in front of the digitizer may be utilized to reduce the required gun-current. Secondly, a computer program has been initiated to establish the field-formation accurately, hence the electron trajectories, in front of and within the digitizer apertures. Thereby the ratio of target-current to gun-current can be maximized.

Preparatory to Phase-II, a preliminary study of high current-density guns has been started, in particular the laminar-flow Pierce gun. This effort will establish the range of operating voltages needed and the heating effects that will occur under conditions of high writing-speeds. It will also provide data that will permit optimized trade-offs between gun and digitizer parameters.

A considerable amount of literature exists on the Pierce gun and

on variations in its configuration. In particular, these designs have been employed in traveling-wave tubes and in high-power klystrons. Experience from earlier work exists in-house, including drawings and specifications.

To keep the operating voltage low, a perveance of 10^{-5} is desired. The cathode area is expected to provide a maximum current of 150 mA with a 0.3 A/cm^2 cathode-loading. As in the Westinghouse Tube Types WX-4732 and WX-4880, a sintered nickel matrix, 5-10 mils thick, upon an INCO #220 nickel button, will be used as the basic emitting-surface design. This porous surface will be saturated with triple-carbonate active coating, dried, and compacted with a stainless-steel ball of the appropriate diameter. This is expected to provide a uniform emitting surface having the precise curvature required by the Pierce gun configuration.

The best anode shape will be determined by means of in-house data and the literature; and the trimming-disc electrodes - which will be an integral part of the gun structure - will be spaced from the anode by self-jigging ceramic washers from the anode. The gun will consist of two distinct subassemblies: the anode and trimming-disc structure subassembly and the cathode and heater subassembly. The preliminary design will endeavor to make the cathode and heater subassembly replaceable with the minimum of effort, so that cathode curvature adjustments can be made easily.

The program planned for this study consists of a paper design of the gun based on previous experience and on the literature. A demountable working model will be assembled wherein, for experimental purposes, the focus electrode will consist of a series of about five annular disks between cathode and anode. The beam-current will be measured and its

uniformity determined photometrically on a phosphor screen in the structure described below in Section II-D, properly modified for this application.

C. READING GUN

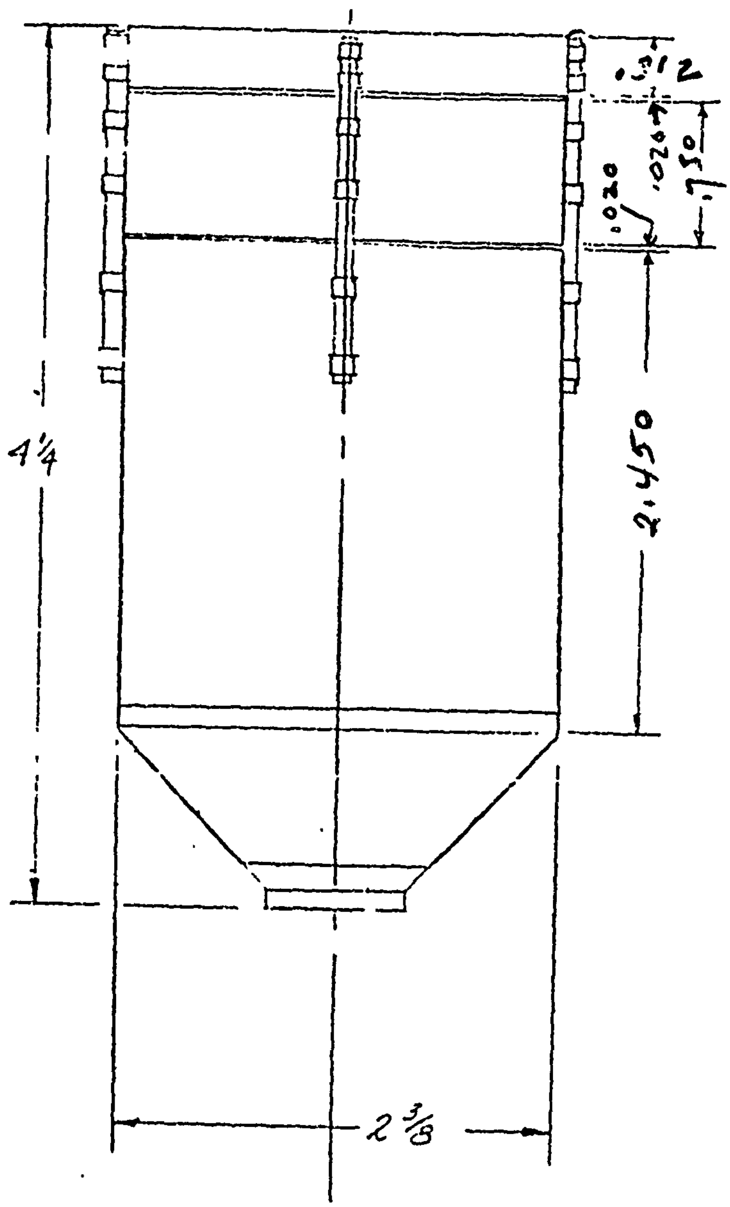
As discussed in the First Quarterly Report, the choice for the reading gun is the Westinghouse ESRB (Electrostatic Return Beam) vidicon structure, Type WX-30373, since its electrical characteristicss and geometric dimensions fit the requirements of the scan-converter tube. The wider scan capability of 1.5 inches square, presently needed, is provided by changing the upper gun-assembly as shown in Figure II-11. To permit heliarc welding to the digitizer housing, the envelope is modified as seen in Figure II-13, which shows the assembled gun ready for sealing to the digitizer housing. The details of the gun, less the envelope, are shown in Figure II-12, and the electrical data are given in the First Quarterly Report.

All parts, including the flanges and deflectrons, have been received, and the assembly of two starts is in progress. Completion of the tube subassemblies is expected in late May.

D. DEMOUNTABLE DIGITIZER TEST FIXTURE

Before committing a digitizer assembly for inclusion into a sealed-off WDX-233, it will be tested in a demountable system in approximately the same electro-optical and physical environment as provided by the tube. This procedure will enable us to:

- Check the electron-optics of the flood-gun structure, specifically the uniformity.
- Determine the optimum electrode potentials for the writing flood-gun.

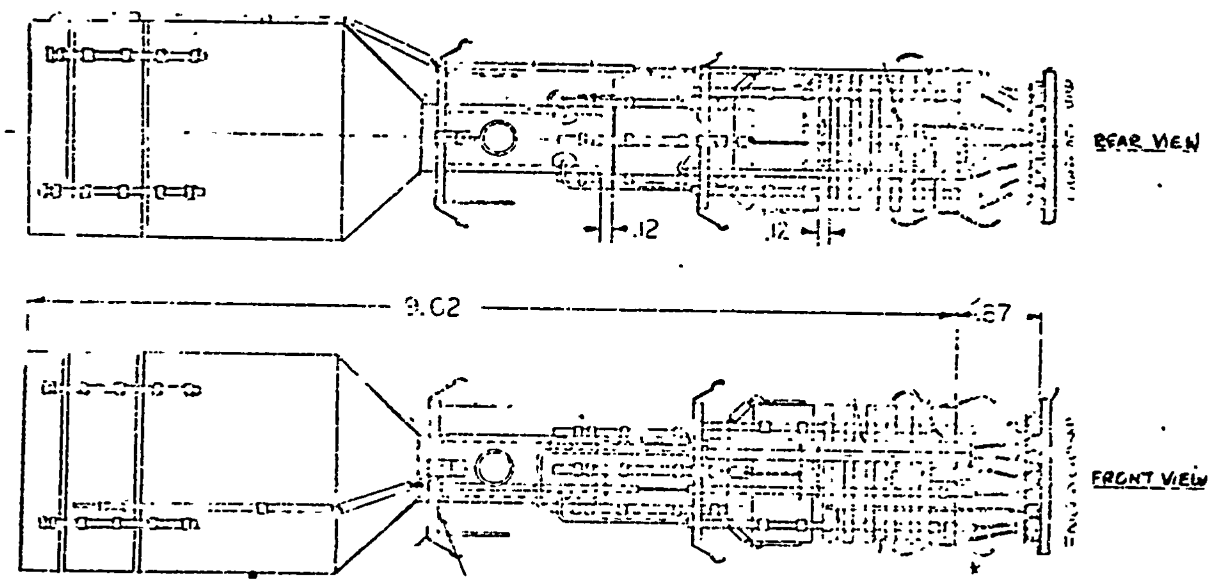


All Dimensions Given in Inches

Figure II-11. Revised ESRB Upper Gun-Assembly

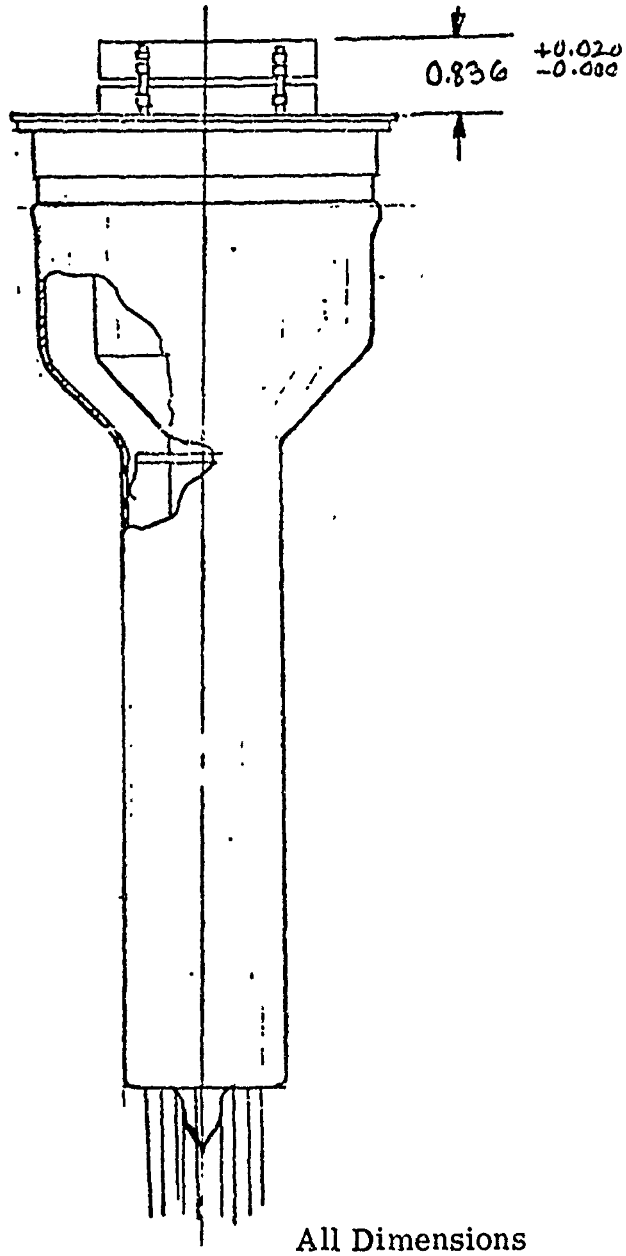
PIN CONNECTIONS

PIN NO.	ELEMENT
1	HEATER
2	IC. DY1-G2
3	VERTICAL DP
4	G5 FOCUS
5	DY 3
6	COLLECTOR
7	G4 ACCELERATOR
8	DY 5
9	G3 PERSUADER
10	G7
11	DY 4
12	VERTICAL DP
13	DY 2
14	G6 COLLIMATOR
15	DY 1-G2
16	HORIZONTAL DP
17	HORIZONTAL DP
18	G1
19	CATHODE
20	HEATER



All dimensions given in inches.

Figure II-12. Revised ESRB Partial Gun-Mount



All Dimensions
Are In Inches

Figure II-13. Reading Gun

- Check the electron-optics of the digitizer.
- Determine the optimum electrode-potentials for the digitizer.
- Check the uniformity of the digitizer output.
- Test the vacuum integrity of the electrical connectors sealed into the cap holding the base-plate.
- Outgas the digitizer assembly prior to inclusion in a sealed-off tube.

In order to provide compatibility between WDX-233 and the demountable Test Fixture, the latter design was based on the WDX-233 structure.

As shown in Figure II-14, the Demountable Test Fixture consists of a digitizer housing, redesigned to permit a high-temperature O-Ring seal to be made to the digitizer assembly using hold-down clamps, a viewing port, and a write-gun assembly.

The O-Ring is either a gold wire or a plated hollow tubing*, permitting the complete demountable to be baked to 300-350°C. It will require that the bottom portion of the cap and the O-Ring step on the test fixture housing have an 8-microinch finish where they are in contact with the O-Ring. It will also permit using the test fixture housing and the digitizer assembly over and over again, or until the write-gun loses emission significantly. The write-gun assembly is identical to that used in the WDX-233. The housing design, however, is revised to provide a viewing port, through which the aluminized sensing phosphor-layer can be observed.

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*As made by the Advanced Products Company, North Haven, Conn. 06473, for example

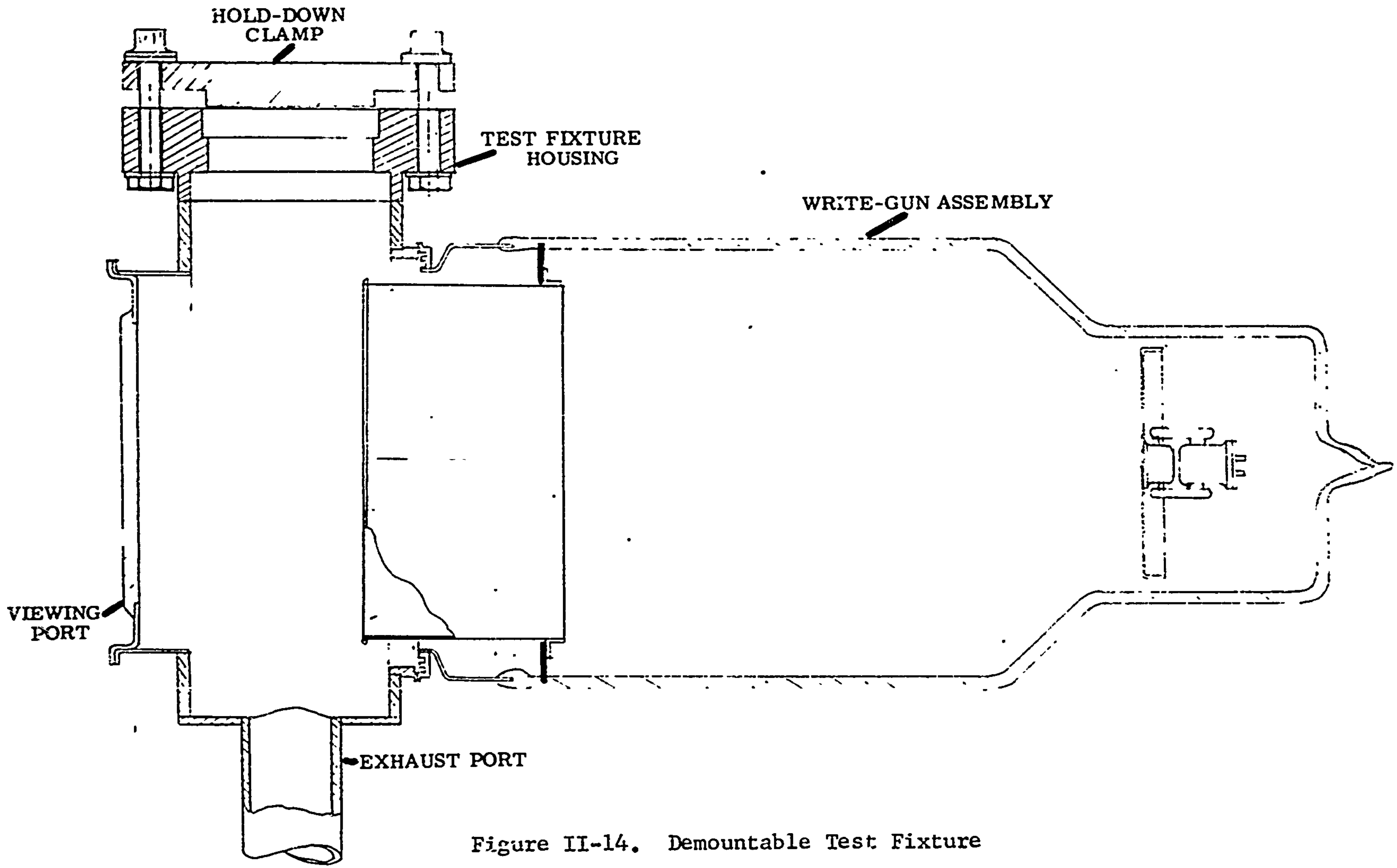

Figure II-14. Demountable Test Fixture

The test fixture will be used first to check the beam-uniformity of the write-gun assembly, and therefore the electron optics of that assembly. Figure II-15 shows how a phosphor-plate and decelerator-mesh are placed, the phosphor-plate being at the plane normally occupied by the first digitizer-plate. The uniformity of luminance over the phosphor area caused by the beam landing upon it will be measured quantitatively with a Spectra spot-photometer through the viewing port.

Once the optimum operating conditions are determined for the write-gun, and the uniformity of the flood-beam has been mapped, the phosphor and decelerator mesh holder can be removed, and the digitizer assembly under test can be substituted. (See Figure II-16) This assembly will have an aluminized viewing-phosphor placed where the storage-mesh normally is located, so that the uniformity of the beam emerging from the digitizer assembly can be measured and compared with the uniformity of the flood-beam. At this point the potentials required for optimum operation can be determined and switching experiments can be run to determine proper operation of the component parts of the digitizer. It is here that problem areas can be detected and resolved prior to installation of the digitizer assembly into the sealed-off tube.

At this point the exhaust schedule for the sealed tube can be shortened by baking out the digitizer assembly in the demountable test fixture. Deleterious effects caused by vacuum and thermal processing can be detected at this point by carefully inspecting and testing the digitizer assembly after the demountable test and prior to installation in a sealed-off tube.

In addition to serving as a pre-processing station, the demountable

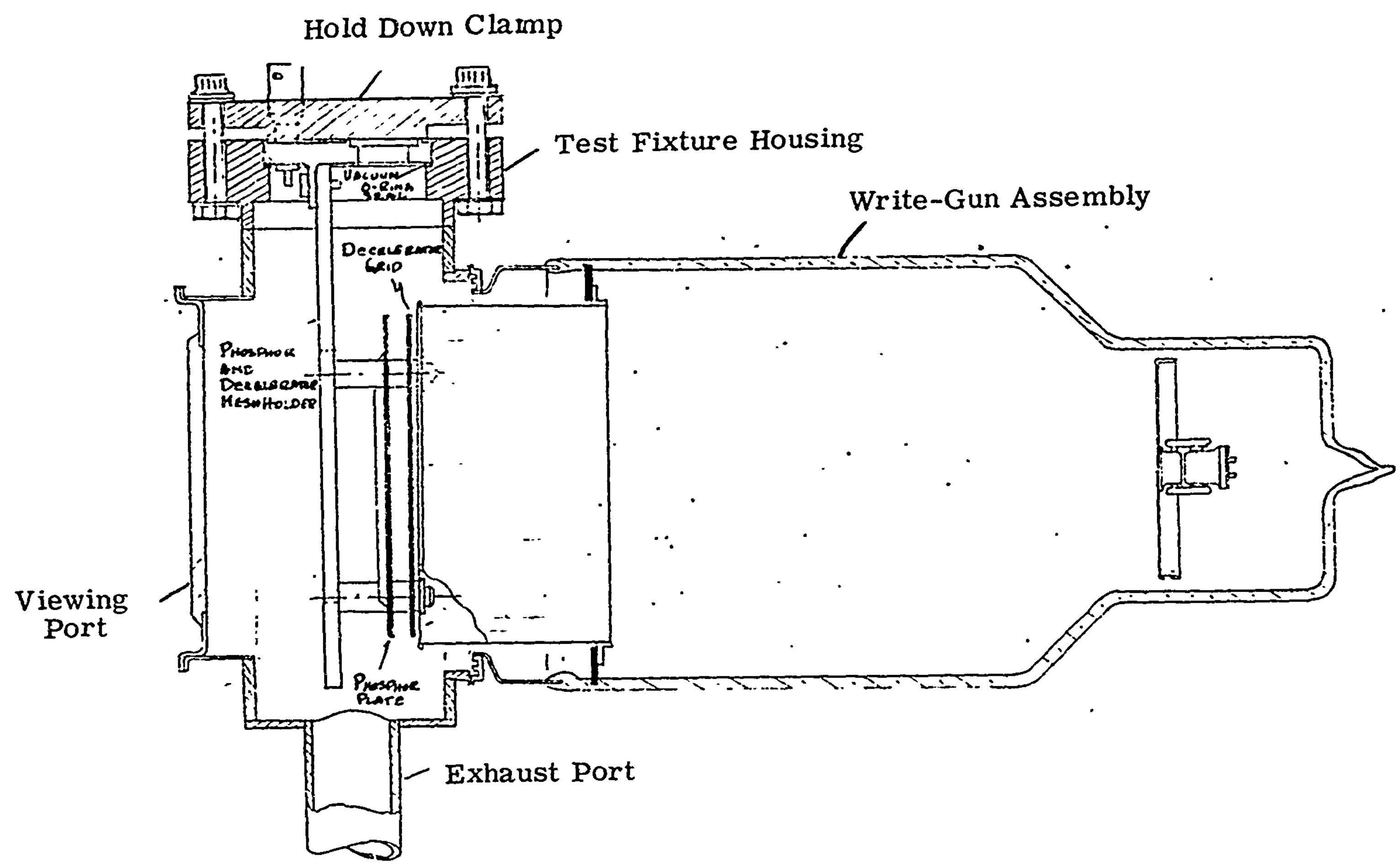

Figure II-15. Flood-Gun Uniformity Test in Demountable Test Fixture

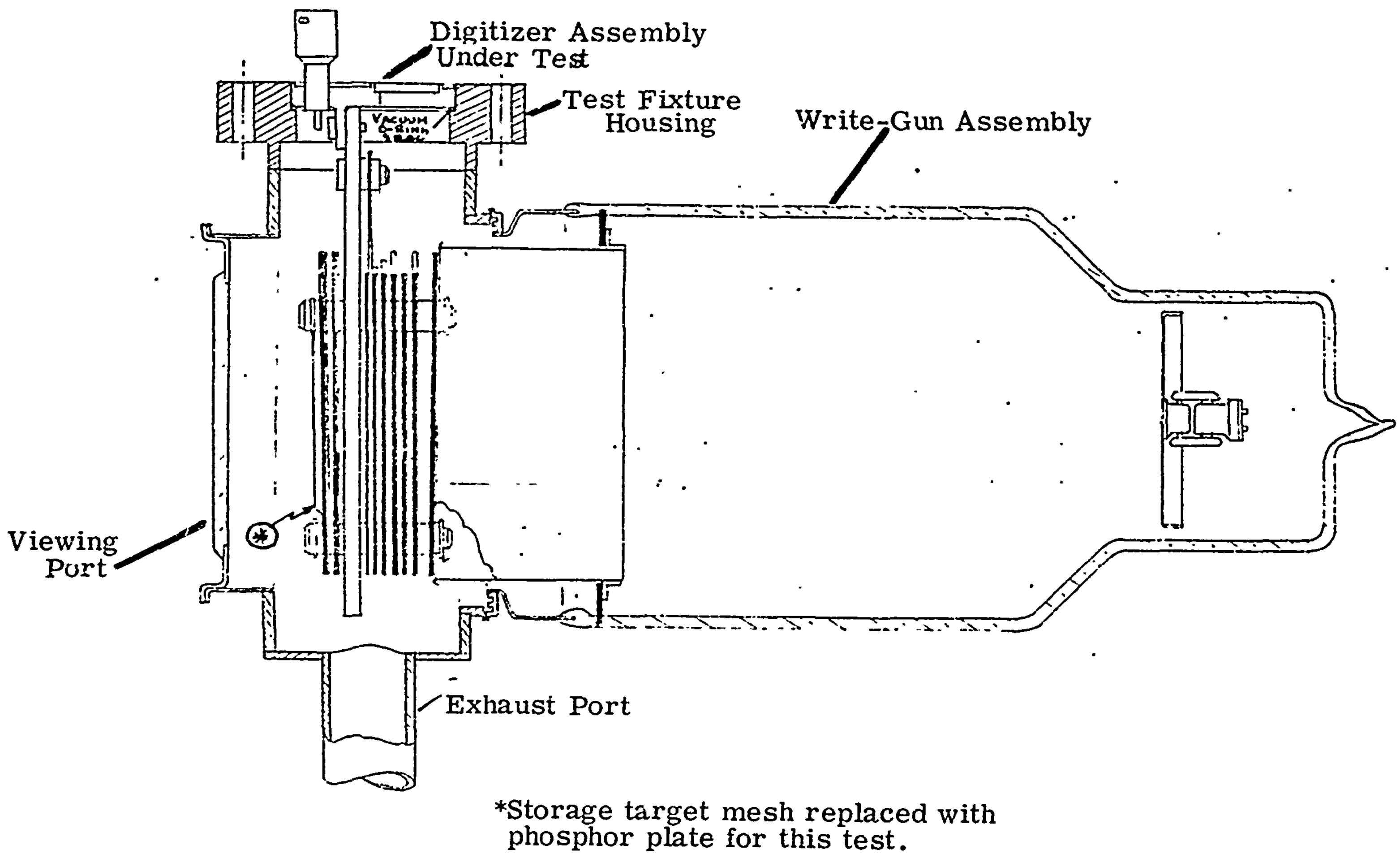

Figure II-16. Digitizer Test in Demountable Test Fixture

test fixture is expected to be useful in providing early warning of any problem areas, or detecting processing-induced failures before a sealed-off tube is assembled from the pre-processed digitizer assembly. Finally, the demountable test fixture can determine the electrical operating conditions required for the combination of digitizer and write-gun, through actual operation.

III. CONCLUSIONS

The experiments with laser drilling of the silicon wafers have been successfully completed, including drilling of a 100 by 100 test-array by means of our numerically-controlled step-and-repeat laser-drilling station. Because of scheduling difficulties an additional station has been procured and is expected to be operational in early June, at which time the complete arrays will be drilled.

The contact strip patterns have been laid out and are ready for being put on numerically-controlled tape. The various fixtures have been manufactured that are needed for photoresist exposure, for alignment of contact strips vs hole-array, and for grinding notches that will provide registry of the hole-arrays of the sequence of wafers.

A detailed computer-program has been started that will accurately determine the electrostatic fields and the electron paths ahead of and within the digitizer holes. A preliminary study has also been made of high-current writing-guns. Both of these studies are made to optimize performance of the final, high-writing-rate scan-converter tube. Parts for the digitizer assembly, as well as for both guns, are in the process of being manufactured.

IV. PROGRAM FOR NEXT QUARTER

The alignment notches will be diamond-ground in a stack of 90 silicon disks to assure identical orientation.

The masks for the contact strips will be made, the photoresist will be exposed, and the contact strips will be deposited on the disks.

The additional laser-drilling station and the numerically-controlled step-and-repeat equipment that have been procured will be tried out and used to drill the 512 x 512 hole-arrays in the six silicon disks.

The demountable test station will be manufactured.

V. IDENTIFICATION OF PERSONNEL

Name and Title	Man Hours Worked This Period
D. Mergerian Program Manager	12.0
J. W. Ogland Fellow Engineer	215.0
I. Limansky Fellow Engineer	374.0
H. J. Bourg Engineer	108.0
H. F. McRae Senior Engineer	9.0
Technicians	294.9